

auxiliary battery module during operation of the electric vehicle, the integrated cooling system comprising a conduit for circulating coolant within the auxiliary battery module.

[0008] According to an example, an auxiliary battery module system for an electric vehicle, the electric vehicle suitable for transporting human occupants or cargo, is described. The auxiliary battery module system includes: means for attaching an auxiliary battery module to an electric vehicle, the auxiliary battery module being configured to be removable from and reattachable to the electric vehicle, said means for attaching electrically connecting the auxiliary battery module in parallel with a primary battery of the electric vehicle; means for providing electrical power from the auxiliary battery module to an electric motor of the electric vehicle via a first electrical connector at the auxiliary battery module and a second electrical connector at the electric vehicle that mates with the first electrical connector for propelling the electric vehicle; means for monitoring a temperature of the main battery of the electric vehicle and a temperature of the auxiliary battery module; and means for cooling the auxiliary battery module based on said monitoring with an integrated cooling system of the auxiliary battery module during operation of the electric vehicle, the integrated cooling system comprising a conduit for circulating coolant within the auxiliary battery module.

BRIEF DESCRIPTION OF THE FIGURES

[0009] FIGS. 1A-1C illustrate an exemplary electric vehicle system including an electric vehicle with a primary battery and including a removable auxiliary battery module that can be removed from and reattached to the electric vehicle according to examples of the disclosure.

[0010] FIG. 2 illustrates exemplary dry-break fluid connectors that may be utilized to pass coolant between an electric vehicle and an auxiliary battery module according to examples of the disclosure.

[0011] FIGS. 3A-3C illustrates exemplary attachment components for attaching an auxiliary battery module to an electric vehicle according to examples of the disclosure.

[0012] FIGS. 4A-4C illustrate another exemplary electric vehicle system including an electric vehicle with a primary battery and including a removable auxiliary battery module that can be removed from and reattached to the electric vehicle according to examples of the disclosure.

[0013] FIGS. 5A and 5B illustrate exemplary block diagrams of an electric vehicle and an auxiliary battery module according to examples of the disclosure.

[0014] FIGS. 6A-6D illustrate block diagrams of exemplary thermal management systems for cooling a primary battery of an electric vehicle and an auxiliary battery module connected to the electric vehicle, wherein coolant from the electric vehicle is used to cool the auxiliary battery module according to examples of the disclosure.

[0015] FIG. 7A illustrates an exemplary removable auxiliary battery module that can be removed from and reattached to an electric vehicle according with an integrated, independent cooling system to examples of the disclosure.

[0016] FIGS. 7B-7D illustrate block diagrams of exemplary thermal management systems for cooling a primary battery of an electric vehicle and an auxiliary battery module connected to the electric vehicle whose thermal management systems are separate and distinct according to examples of the disclosure.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0017] FIG. 1A illustrates an exemplary automotive electric vehicle system comprising an electric vehicle **100** and a removable auxiliary electric battery module **102** that can be attached, removed, and reattached to the same electric vehicle **100** or a different electric vehicle to provide additional power to the powertrain of an electric vehicle for propelling the vehicle as may be desired according to an example of the disclosure. As shown in FIG. 1A, the exemplary electric automotive vehicle **100** includes a body **104**, multiple wheels/tires **106**, a cabin **108** sized for one or more human occupants, one or more doors **110** that provide access to the cabin **108**, and a cargo area **112** (e.g., cargo bed) including a support surface **114** and side members **116** (e.g., bed sides). The electric vehicle **100** may also include a cargo area door **118** (e.g., tailgate). The electric vehicle **100** also includes one or more electric motors (not shown in FIG. 1A) for propelling the electric vehicle **100** and a primary battery (not shown in FIG. 1A) for providing electrical power to the electric motor(s) for propelling the electric vehicle **100**.

[0018] The electric vehicle **100** is suitable for driving on roadways and may be shared among a plurality of users (drivers) or among a plurality of uses controlled by an entity (owner or other responsible entity) to permit enhanced utilization of the vehicle **100**. The vehicle **100** may be configured for driving by a human driver or configured for autonomous driving without a human driver. For autonomous driving without a human driver, the vehicle can be configured with an array of sensors, including LIDAR (light detection and ranging), camera systems for acquiring real-time video imagery of obstacles and other vehicles, GPS (global positioning system), wireless communication systems for sending and receiving communications regarding road information and traffic in real-time, as well as a computer for applying driving rules and making driving decisions based on data and information acquired from the foregoing, in a suitable manner such as conventionally known in the art.

[0019] As shown in FIG. 1C, the exemplary auxiliary battery module **102** comprises a battery housing **103** and a battery disposed therein comprising a plurality of individual battery cells (not shown), and those battery cells may be arranged and configured within the auxiliary battery module **102** in any suitable manner such as conventionally known in the art for powertrain batteries for electric vehicles. The auxiliary battery module **102** may be configured to provide, for example, 10 kWh, 15 kWh, 20 kWh, etc., of electrical energy and may weight several hundred pounds or more. Accordingly, the battery housing **103** and any inner supports for the auxiliary battery module **102** should be constructed of sufficiently strong materials, such as metal alloys, fiber composite materials, combinations thereof, etc., so as to support the weight of the auxiliary battery module **102** and provide sufficient strength in the attachment regions thereof, to accommodate normal expected use and remain secured in potential collision events. The corresponding supporting portions of the electric vehicle **100** should likewise be constructed of such materials to sufficient strength. The main battery may be configured to provide, for example, 50 kWh, 70 kWh, 100 kWh, etc., of electrical energy, and it will be appreciated therefore that the auxiliary battery module can